The Mining Journal

Established 1835

Railway & Commercial Gazette

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NOTES AND COMMENTS

Australia's Gold Mining Industry Assistance Act, 1954

The Commonwealth Government's Gold Mining Industry Assistance Act, 1954, has been favourably received in Australia. The Act provides for the payment of a subsidy to assist marginal producers, in the financial years 1954-55 and 1955-56. For the purposes of the Act, producers are classified into large and small. Large producers are those whose output exceeds 500 oz. per year and small producers are those who recover less than 500 oz. in the particular year.

The formula on which the subsidy is calculated for large producers is that for each oz. of fine gold produced in a subsidy year, the subsidy will be three-quarters of the amount by which the average cost of production exceeds £A13 10s. The maximum payment is £A2 per oz. For the small producer there is a flat rate subsidy of £A1 10s. per oz. The main condition applying to the small producer is that the value of gold delivered must be more than one-half of the total value of the producer's mining output for the year, and that the subsidy is reducible to the extent that the producer obtains more than £A15 12s. 6d. per f.oz., excluding subsidy, for his gold.

Cost of production, to the nearest pound, is itemized as mining, treatment, development, realization charges, general expenses, head office expenses, depreciation, and other. The Treasurer may determine what constitutes a separate mining company, and in making such determinations, the main test will be whether a producer's gold mining operations can be regarded as constituting more than one business enterprise.

Mining Expansion in the Overseas Territories

Indications of the immense contribution which mining is making to the progress and prosperity of " under-developed areas " are given in a recent O.E.E.C. publication, *Economic Conditions in the Overseas Territories*. The territories reviewed are those with which the United Kingdom, France, Belgium, Portugal, the Netherlands and Italy have special links.

The Overseas Territories have a total population of roughly 150,000,000. Their share in world trade is about 10 per cent. It is roughly since 1948 that development plans have been launched in most territories. During the same period, and especially since 1950, most territories have benefited from strong external demand for their products and favourable terms of trade. In almost all the territories, development is stimulated, co-ordinated and in part financed in accordance with specific plans. The development of industry and agriculture is generally left to private enterprise. The aim is to guide the economy without imposing any rigid form of control.

In the African territories of the United Kingdom the products whose output increased to the greatest extent between 1937 and 1952 include copper, iron ore, diamonds, bauxite, hardwoods, and a variety of agricultural produce. As compared with pre-war, mining is the industry which has developd most. Mine production represents about one-third of exports. Copper is the main product and its output has almost doubled since the war, as has manganese production. Diamond output has increased by 30 per cent, while gold and tin production is stationary. There are considerable mineral reserves, particularly in Uganda and the Gold Coast. In the latter territory the Volta River Scheme is under consideration by a Preparatory Commission. The mining industry is therefore likely to play an increasing part in the economic life of the United Kingdom territories in Africa.

In the British West Indies region it is noteworthy that, although agriculture remains the basis of the economy of this group of territories, over 40 per cent of exports now consist of Trinidad oil and bauxite from Guiana and Jamaica. Bauxite production has increased five-fold and British Guiana has become the second world producer.

In the French North African territories also, the mining industries have expanded more rapidly than agriculture. Phosphate, iron and lead are the three main mineral products. Phosphate production is about 50 per cent above the pre-war volume, but there has been little progress since 1949. Extraction of iron ore is increasing fairly rapidly, lead output has doubled since 1948, while zinc and manganese output are five times the pre-war figure. Only a small proportion of these ores is processed locally.

In the French Central African territories mining

is still relatively underdeveloped and accounts for only three per cent of exports. Prospects are considered very favourable, however, for recently worked deposits such as phosphates, bauxite and iron, or recently discovered deposits such as manganese in Equatorial Africa. Large-scale projects are being considered for the development of electro-metallurgy, following the establishment of large electric power stations in Guiana, the Cameroons and French Equatorial Africa. Since 1949 the production of electric power has been doubled and it will be doubled again between 1953 and 1956. Madagascar's mining industries (graphite and mica) have remained stationary.

Little progress has as yet been made in developing the resources of French Guiana, where bauxite could be mined. The economy of New Caledonia is based on nickel production, at present at high cost.

Since 1950, the economic expansion of the Congo has made rapid progress, especially in mining and the processing industries. Production of electric power increased by 78 per cent from 1950 to 1953, and the tonnage carried by the railways by 39 per cent. The index of copper production (which represents about 50 per cent of the value of mining production) rose from 80 in 1949 to 122 in 1953. Cobalt output, which was less than 1,000 tons before the war, exceeded 8,000 tons in 1953, and the Congo provides 75 per cent of world production. Production of zinc concentrates rose from an average of 7,000 tons before the war to 126,000 tons (metal content). Manganese production has increased 12 times since 1950. There is little information on the production of uranium.

The expansion of industrial production is even more indicative of the economic development of the Congo. It has doubled in four years and is said to be six times greater than before the war. It covers a wide range of industries and in some instances, as in the use of cement, local production already supplies the greater part of the domestic demand.

Mining has made considerable progress in the Portuguese territories of Angola and Mozambique. Excluding diamonds, however, it still provides a little less than two per cent of exports by value. The output of copper has doubled, that of manganese has increased more than three-fold, while oil production has increased about ten-fold, but all these forms of production are virtually only starting. Diamonds account for seven per cent by value of exports of the two territories combined, but output seems to be slightly declining.

In many cases the progress of the Overseas Territories has been remarkable. Mining output in general has increased appreciably, commercial crops have increased substantially, and the processing industries have made rapid strides in the Congo, Kenya and Morocco. Progress has been slower in most territories, however, for the subsistence food crops on which the level of consumption of the local population mainly depends.

In the French territories, and in certain United Kingdom territories, investment of private capital is still inadequate. Other commentators have drawn attention to the long periods sometimes elapsing in the French territories between the discovery of mineral occurances and their exploitations. Thus indications of iron ore were found in Guinea before 1914 and about 1922 an American group spent $600,000 on preliminary exploration. Yet it was not till after the second world war that commercial exploitation began. It is also suggested that most of the high-grade deposits are now known, leaving only marginal occurences to be opened up. Stress is laid on the long-term importance of research on these marginal ores, although the rewards may not be forthcoming for many years.

The growing cost of bringing a new mine to production is also a serious problem. For example, the total expenditure of the Cie Minière de Conakry on exploration and construction was in the region of Fr.6,000,000, which is equivalent to three or four times the actual or potential annual profit. Unfortunately these millions of francs are now very difficult to find on the French or even European financial market.

It is perhaps significant that in the financing of mining ventures in French territories a leading part is being taken by the industrial users of the minerals, whose interest lies in the assurance of future sources of supply. Thus the British iron and steel industry has advanced a third of the capital of the Cie Minière de Conakry and Canadian aluminium producers almost the whole of that of the Societé des Iles de Loos, repayment being made in the form of iron ore or bauxite respectively.

Meanwhile exploration continues to be vigorously carried out, particularly in North Africa. The Bureau d'Organisation des Ensembles Industriels Africains (B.I.A.) states in its latest report that 89 per cent of its resources were directed last year to mining operations in the Sahara, with encouraging results. At Djebel Berga an occurrence of natural gas has been discovered. Attention is being given to the possible utilization of 800,000 tonnes of manganese near Djebel Guettara near Beni-Abbes for the local production of ferro-manganese. Occurrences of copper ore located at Djebel Klakli and Tizi-Moudo are estimated to contain respectively 60,000 tonnes and 80,000 tonnes of ore averaging three to four per cent copper.

Despite all its difficulties, the mining industry is clearly making a major contribution to the development and prosperity of the French overseas territories.

Aluminium Limited's Need for Rigid Expansion

The appreciable tonnage expansion of aluminium smelting capacity in North America during the past year or so has failed to prevent a shortage of aluminium ingots and *a fortiori* talk that the third round expansion scheme should be revived.

Certainly the recent proposal from the Aluminium Company of Canada, the chief subsidiary of Aluminium Ltd., to raise production capacity at Kitimat has been rooted in the belief that the present high level of demand will continue. More than that, it is based on the belief that this demand will increase in the months ahead and that in the longer team the overall picture will show that U.S. demand will outrun its production capacity.

The annual report of Aluminium Ltd. for 1954, points out that the whole of the company's output is being marketed. But even so, it has not been able to meet all demands. This, perhaps, explains why the company did not enter into any long-term commitments last year. A partial breakdown of the sales figures revealed that, although shipments to the United States in 1954 of 192,560 s.tons in ingot form represented a substantial decline from the 1953 peak of 237,000 s.tons, it was still two-and-one-half times greater than shipments effected in 1949. On the other hand, deliveries to the United Kingdom in 1954 advanced from 184,600 s.tons in ingot form to 221,800 s.tons last year.

The present installed capacity of Alcan's Kitimat-Kemano smelter, which was brought into commission last August is approximately 91,500 s.tons, but last October an additional 61,000 tons was authorized while the programme announced on March 16, 1955, when completed, will add a further 180,000 tons, making a total of 331,500 tons per year.

Total production of aluminium from all Alcan sources in 1954 amounted to 560,900 tons, including some 20,000 tons from Kitimat which will raise its output in 1955 by an-

other 70,000 tons. This will be necessary if the company is to meet its long-term commitments to supply the U.K., the U.S. fabricators and Kaiser and Alcoa.

The whole burden does not fall on Alcan, however, and Aluminium Ltd. is expanding its bauxite operations in Jamaica. Present production capacity is to be expanded to 300,000 tons a year and provision is to be made to increase this to 500,000 tons should that be required. In any event, the company's subsidiaries are producing bauxite at a rate of 2,200,000 tons in British Guiana, 495,000 tons in French West Africa, and 230,000 tons in Jamaica. Moreover, production by subsidiaries or affiliates in Italy, India, Brazil, Japan, Norway and Sweden were all operating at capacity levels last year and so far as the future can be anticipated will continue to do so whether the third round expansion programme is revived or not.

Western United States

(From Our Own Correspondent)

Portland, Oregon, April 3.

The practicality of the policy of Defense Mineral Exploration Administration in advancing funds for mine development is borne out in a recent report by Secretary of the Interior, Douglas McKay. The report states that 169 projects certified to date called for the expenditure of $7,629,000, of which the Government agreed to supply $4,782,000 but actually expended only $3,591,000. The result was the development of ore reserves of an estimated value of $200,000,000. Sixty per cent of the certified projects have made repayment on their loans through royalties on production and some of them have paid out in full.

The Department of Agriculture is making plans to set up its own stockpile to be maintained by exchange of foodstuffs held by Commodity Credit Corporation for strategic materials held abroad. Included in the list to be acquired are manganese, cobalt, iodine and mercury.

A sub-committee of the Senate Interior and Insular Affairs Committee will make an investigation of the stockpiling programme to determine how effective it has been in aiding the domestic mining industry. This sub-committee is the successor to the Malone committee of the last Congress but is Democratic in complexion instead of Republican. Senator Malone continues as a member but not as chairman.

LABOUR RELATIONS

The battle between the National Labour Relations Board and the Mine, Mill and Smelter Workers' Union continues. The union has won the latest round. The N.L.R.B. issued an order barring Mine-Mill from using the services of the board because its secretary, Maurice E. Travis, had admitted in the union's newspaper that the non-Communist affidavit he filed in compliance with the Taft-Hartly law was false but the union secured a preliminary injunction in Federal Court restraining the board from enforcing the order. Mr. Travis is presently under Federal indictment for perjury in this same connection.

Meanwhile purging of the union may come from within its own ranks. Some of the locals have long realized that Travis is a millstone about their necks and recently the Butte local, largest and oldest of Mine-Mill affiliates, voted two to one to request his resignation and it is believed that a very large number, perhaps a majority, of the union's total membership is of the same mind. If Travis is forced out there is little doubt that Communist domination of Mine-Mill will crumble.

Both A.F.L. and C.I.O. officials are refusing in no uncertain terms feelers that Mine-Mill be accepted into the Single Trade Union Centre, the name tentatively assigned to the proposed merger of the two big unions. Meanwhile both of these are continuing their proselyting of Mine-Mill, C.I.O. through steelworkers and A.F.L. through a special department for mine workers now being organized. None of this affects the coal industry which has its own union, the United Mine Workers of America.

U.S. URANIUM PRODUCTION CONSOLIDATES

In testifying before the Congressional Joint Committee of Atomic Energy Dr. Jesse Johnson of A.E.C. stated that although foreign ore is being imported in increasing quantities, it is his belief that domestic production could support consumption for some years to come if both continue at the present rate. He estimated that a minimum inventory of 600 tons would be necessary to initiate a programme of atomic power generation and that an annual replacement of 50 tons would be required to maintain it.

Dr. Johnson recommended as an encouragement to private capital that an advance supply sufficient for seven to ten years be maintained and that producers be given five years' notice of a proposed change in policy. A Colorado official stated recently that more uranium ore is being mined now from the Rocky Mountain region than is being imported from Africa and Canada. The Rocky Mountain region embraces not only the Colorado Plateau but the Wyoming and Black Hills deposits.

The inevitable litigation that seems bound to arise in any district that has been subjected to such hectic development as has the Colorado Plateau has started. Several title suits are now pending in the courts, the latest being Climax Uranium, subsidiary of Climax Molybdenum, against Hidden Splendor, the company that acquired the Vernon Pick properties in a $9,000,000 deal last summer. Climax asks that Hidden Splendor be enjoined from drilling certain lands until the property rights can be adjudicated.

Mr. Marvin Kay, vice-president of Climax stated that the question of title arises over the fact that present Federal and state laws, passed in the days when mining was based on lodes, cannot be applied literally to the conditions under which uranium occurs. The land involved in the Climax suit is in Utah but similar difficulties have arisen in Colorado and the legislature of that state is considering drastic revision of the state laws. Mining claims are located under Federal laws but the states are empowered to modify the law as long as the state laws do not liberalize the Federal statute.

Some time ago it was forecast in this column that as the potentialities of the Colorado Plateau became realized there would be a tendency for large companies to move in and smaller companies to merge into greater corporations. The interest of the large companies has been noted for some time, Utah Construction Co., known the world over for its massive construction products, being one of the latest to enter the uranium field with a lease in Arizona but not in the Plateau region proper.

Now the merger movement seems to be well under way, most notable to date being that of Federal Uranium Corporation, controlled by Floyd Odlum whose Atlas Corporation bought the Delta mine of Vernon Pick last year. Federal is merging with six other companies, best known of which is U. and I. Uranium, Inc., the uranium enterprise of six lead-zinc mining companies of Idaho's Coeur d'Alene district. The merger will give Federal control of the largest acreage of any company on the Colorado Plateau. Lesser mergers are Sterling Uranium Corporation which consolidates four companies and purchase of control of Standard Uranium by Mr. Charles Steen, whose Mi Vida mine was the first big bonanza of the Plateau area.

HYDRAULIC TRANSPORT—I

The Hydraulic Transport of Solid Material in Pipes

The growing interest in the hydraulic conveying of solid materials in pipes has revealed the lack of data for the design of these systems, and to meet this need extensive research work has been undertaken both in the United Kingdom and overseas. The following article, wherein the more important results of this research are summarized, is condensed from a paper under the same title presented at a general meeting of The Institution of Mechanical Engineers in London on Friday, March 25, 1955. The authors, R. C. Worster, B.Sc.(Eng.), and D. F. Denny, B.Sc.(Eng.), Ph.D., are respectively graduate and associate members of the Institution. In the first portion of the article presented herewith, the flow of materials through various inclinations of pipes is discussed, while two subsequent instalments will describe in turn methods of pumping solids and the depreciation of transported material and operating plant. Although the article is more concerned with the transportation of coal, it is worthy of note that for many years the hydraulic transportation of solids in pipes has been successfully applied in specialized fields, one of which is the winning of certain minerals.

The behaviour of mixtures of solid particles and a liquid flowing in a pipe differs from that of a simple liquid, especially when the particles are denser than the liquid and their size is greater than about 1/500 in.

In a horizontal pipe, gravity tends to stratify the mixture into two distinct layers, namely, a lower layer of solids and an upper one of liquid. Remixing of these two layers may be achieved by cross-turbulence in the liquid but this occurs only at very high speeds or with relatively fine particles (less than $\frac{1}{8}$ in.).

In a vertical pipe, the flow conditions are simpler. Gravity forces on the particles act in the same line as the pressure gradient and average velocity: the separating effect is then easily overcome and the solids are uniformly distributed across the pipe section.

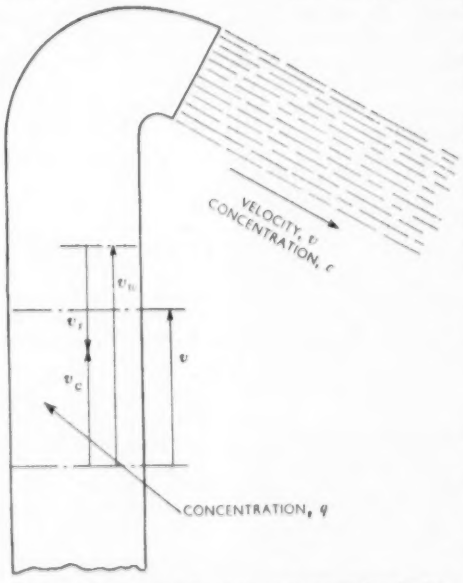
FLOW IN HORIZONTAL PIPES

No method has yet been discovered of feeding a closed-loop laboratory pipeline so that the concentration of solids is kept constant over a large range of velocities. At very high speeds, the pressure gradient along the pipe is little more than that of water alone, flowing at the same mean speed. If account is taken of the higher density of the delivered mixture the difference is still less, but, contrary to earlier suggestions[1] does not seem to vanish completely with solids above about $\frac{1}{8}$ in. It seems fairly certain that the difference does not fall to zero but to a constant value of 0.1 of the concentration by true volume in the mixture delivered, but for practical purposes the increase in pressure gradient due to the solids at high speeds is relatively small.

As the speed diminishes, the pressure gradient for the mixture departs progressively from that for the liquid alone, until it reaches a stage where it is not greatly dependent on speed but only on the concentration and specific gravity of the solids. Still further reduction in speed seems to cause a rise in the pressure gradient.

No satisfactory theory of the motion of mixtures of solids and liquids in horizontal pipes has yet been advanced.

Above about $\frac{1}{8}$ in. or 3/16 in., increasing the size of the solids appears to have little direct effect on the pressure drop. However, if solids below this size are to be transported, considerable diminutions in the pressure drop and permissible velocity will be found until, with particles of the order of 40 microns or thereabouts, no significant differences betwen the mixture flow and the flow of a liquid of the same density may be expected so long as the flow is turbulent. With solid particles between this minimum size and $\frac{1}{8}$ in. the turbulence in the liquid is capable of holding particles in suspension, and these will then contribute very little to the pressure drop along the pipe. The proportion of particles in suspension naturally increases with velocity.



Velocity flow upwards where v is normal velocity in pipe, vc is net velocity of particles in ft. per sec., vs is free falling velocity of solid particles in ft. per sec. and vw real speed of water

LIQUID DENSITY

In some circumstances it may be practical to use a liquid of density greater than that of water. With a simple liquid such as brine, laboratory tests have shown that marked reductions in velocities and pressure gradients are possible. The suspension type of heavy medium is commonly used in washeries to-day and the technique of recovery of the medium exists. There seems no reason why advantage cannot be taken of this kind of heavy medium in any proposal for transporting large coal over long distances, with considerable reductions in costs.

When the pipe wall differs in physical properties from those of steel, or when the solids transported differ from such materials as gravel or coal, significantly different pressure drops may be observed. For instance, lining a pipe with polytetrafluorethylene reduces the excess pressure by about 25 per cent. With rubber particles small in comparison with the pipe, a reduction of pressure drop below the normal also takes place.

The roughness of the pipe walls and ageing effect will not usually be important.

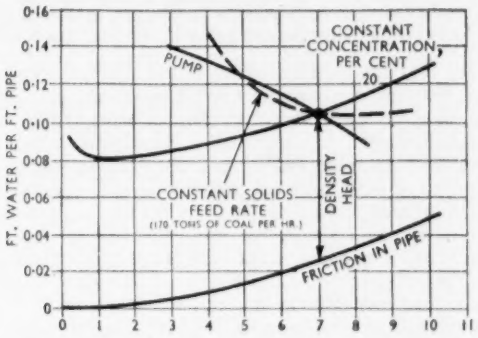
FLOW IN VERTICAL PIPES

In upward flow the solid particles slip backwards at about their free settling velocity. The water consequently travels rather more quickly than the mean speed, and the solid particles rather more slowly, the difference being dependent on the ratio of slip velocity to mean velocity and solids concentration.

In upward flow in a vertical pipe

the volumetric concentration in the pipe is slightly higher than the delivered concentration; the ratio of volumetric concentration to delivered concentration also depends on the ratio of free falling velocity to the normal velocity, and on the concentration delivered.

There are therefore two apparent sources of additional energy loss in vertical upward flow, the excess density gradient and the slight extra water friction. These two terms are, however, negligible at all ordinary pipe speeds.



Velocity in ft. per sec. for flow in vertical pipe

Tests have been made with a 1½ in. pipe system on the pressure drops in pipes inclined both up and down, at several angles. They served to confirm that the excess pressure drop caused by the solids in the sloping pipe was equal to the sum of the excess pressure drops in the corresponding horizontal and vertical pipes joining the same end points.

FACTORS OF STABILITY

The stability of the hydraulic transport system obviously depends on whether the solids feed is a constant mixture concentration or a constant mass flow of solids. The maximum size of solids that can be passed through a pipe is not easy to fix. At low concentrations and high velocities single lumps almost as big as the pipe will even pass safely around pipe bends. It seems that the essential requirement at moderate speeds is that the sliding bed of solids should leave sufficient free space above it for the largest particles to turn over freely. Clearly, therefore, the maximum size of solids being transported depends, at these speeds, on the concentration in the pipe. The rule that the maximum size of solids is limited to one-third of the pipe diameter is only applicable at moderate concentrations if the speeds are low. The speeds that correspond to the minimum in the friction curves increase as the square root of pipe diameter and of the density under water.

As an example of the concentration factor within the pipe, in a 6 in. horizontal pipe a rather low handling speed would be about 5 ft. per sec. At this speed concentration is approximately 28 per cent when delivered concentration is 20 per cent. Since the voids of a closely packed bed of coal are about 50 per cent, the bed occupies a depth of rather more than half the pipe diameter, leaving 3 in. clear space above. In this case the maximum safe size of coal would be about 2 in.

Approximate values are given in the table below for reasonable concentrations of 20 to 25 per cent of large coal or gravel.

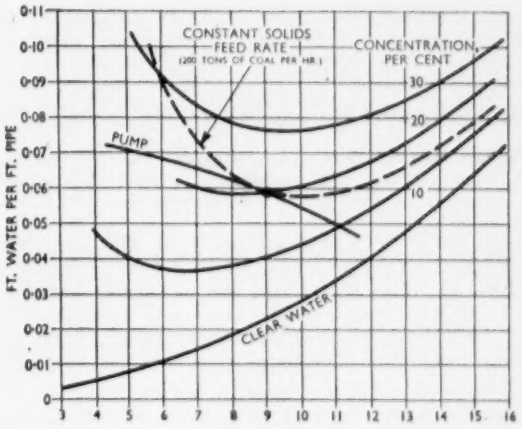
Pipe diameter, inches	*Minimum speed, ft. per sec.*	
	Gravel	*Coal*
1	3	1½
3	7	3½
6	10	5
9	13	6½
12	15	7½
18	17½	8¾

In an emergency it is possible for tightly packed solids to move along a parallel straight pipe, but in flowing around a pipe bend the packed bed must shear internally. In doing this there is a dilatation and the solids are very likely to seize and stop the flow. It is usually at a bend or restriction that a pipeline carrying solids will choke and it may be desirable to provide means of emptying the pipe at such danger spots.

SETTLING VELOCITY OF PARTICLES

The velocity at which a solid particle falls in a liquid is an important factor and, in many ways, is a good measure of the hydraulic effects of the size, shape, and density of the particle. When the particles are not spherical but of irregular shape their settling velocity is reduced, sometimes greatly. Particles of ordinary irregularity such as gravel or coal have a settling velocity of about half or a third that of a sphere of the same "sieve size". The presence of a pipe wall diminishes the settling velocity below that of a freely falling particle.

In more detailed description, a single particle falling in a pipe three times its diameter has its settling velocity halved. However, this effect does not seem to be present with swarms of particles falling. Tests on the effect of concentration on the settling velocity of large particles indicate a linear reduction in settling velocity with increasing concentration. At 30 per cent concentration by volume has fallen to approximately 0.6 or 0.7 of the free falling velocity of single particles. This reduction is greater with finer solids.



Velocity in ft. per sec. for flow in horizontal pipe

It is obvious that a mean velocity of double the settling velocity would be quite adequate for transport up a vertical pipe, that is, 3 ft. per sec. for 3 in. coal. But if a material-raising system is made of the same pipe throughout, then the velocities must be determined from the requirements of any horizontal or sloping sections of the pipeline. These velocities will always be large in comparison with those sufficient for safe vertical lifting, but it hardly seems worth increasing the size of the vertical pipe on this account.

REFERENCES

(1) Durand, R. and Condolios, E., 1952, Société Hydro-Technique de France. *Deuxieme Journées d'Hydraulique*, June. Also pub. Nov. 1952 by N.C.B. 1953 *La Houille Blanche*, vol. 8, p. 292. Also O'Brien, M. P., and Folsom, R. G., 1937, Univ. California *Pub. in Eng.*, vol. 7, p. 343. Also Worster, R. C., 1952, Nov., N.C.B.

COLUMBITE—IV

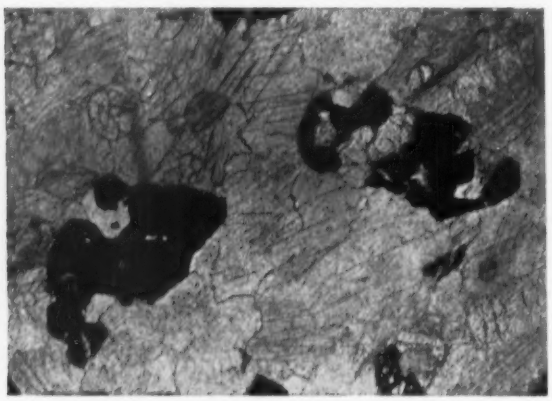
The Niobium Deposits at Söve, Southern Norway

By H. BJÖRLYKKE

In recent issues of *The Mining Journal*, the occurrence and treatment of columbite has been fully described with particular reference to Nigeria, the chief source of world supply. The following article, the fourth in the series, discusses the niobium ore deposits at Söve, Southern Norway, where comparatively recent prospecting and development operations have been completed and where limited mining is currently being carried out. The discovery of these deposits was the essential theme of a despatch from our Norwegian correspondent which appeared in our issue of August 4, 1950. Since that time references to the progress made with their development have been frequent but brief. The author is chief geologist, A/S Norsk Bergverk, which is working the Söve deposits.

The niobium ore deposits at Söve, Southern Norway, occur within a small alkaline rock complex, the so called Fen district, covering an area of about six sq. km. and situated at the shore of Lake Norsjö, near the village of Ulefoss, about 110 km. by air, S.W. of Oslo.

This area has long attracted the interest of Norwegian geologists because of its specific rocks. The first explicit mapping and petrographical study of these rocks was



Niobium ore from the Cappelen Deposit. The dark portions are koppite crystals with inclusions of apatite. The ground mass is calcite and apatite

carried out by W. C. Brögger and V. M. Goldschmidt in 1918-1921, and the results of this work were published by Brögger in 1921.[1] As the chief part of the area is covered by a heavy soil mantle of clay and morainic gravels, however, the mapping of the surface was incomplete and did not exhibit many of the geological features of this rock complex.

The Fen region has been built up by different alkaline silicate rocks and carbonatites, most of which have been given local names after the names of the farms in the district. The rocks in the Fen area are very similar to those of other alkaline rock areas, especially Kaiserstuhl in Germany and Alnö in Sweden.

NATURE OF DEPOSITS

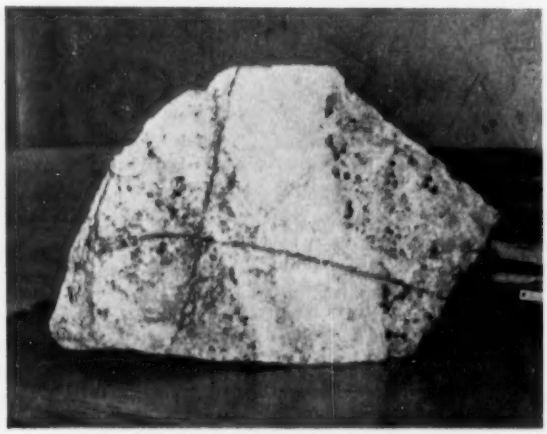
Niobium and tantalum minerals belonging to the pyrochlore groups. The first pyrochlore mineral was found at Fredriksvern, Norway, and was described by Wöhler in 1826. During the field studies in the summer 1918, Professor V. M. Goldschmidt observed some minute octahedral crystals in a crystalline limestone in the Fen area, and the deposits were claimed by the Norwegian Government. Because of an erroneous chemical analysis, the ore mineral was described by Brögger as mikrolithe, until an X-ray spectrographic study by the author of this article in 1932,[2] showed the chief component to be niobium and that the content of tantalum was very small. The mineral therefore, was very similar to the pyrochlore mineral previously described (1875) as koppite from Kaiserstuhl in Germany.

Until 1951 the niobium claims in the Fen area belonged to the Norwegian government when ownership was transferred to A/S Norsk Bergverk, Oslo. During the last war the Germans were very interested in these niobium deposits and carried out some drilling and ore dressing researches. After 1951 a very extensive prospecting and development programme was carried out by A/S Norsk Bergverk, as a result of which considerable mineralization of niobium minerals has been encountered both in the carbonatites and in the nepheline-bearing silicate rocks. The highest grade of niobium ore met with in the carbonatites, however, and therefore in the development work, has been especially concentrated in these deposits.

ORIGIN OF FORMATION

The last year's geological work in this area, carried out by the mine geologist Sverre Svinndal, indicates that the large bodies of carbonatites are of contact metamorphic origin and that the niobium ore minerals must be supposed to have been formed by pneumatolytic and hydrothermal activity. The mineralization seems to have followed certain brecciated zones in the country rocks. The carbonatite rocks form the central part of the rock complex of Söve with an average dia. of about 1,200 m. and with smaller inclusions of silicate rocks. In the peripheric parts of the area some more or less lens-shaped bodies occur also, embedded in silicate rocks, especially the syenitic fenites which form a border around the area. The peripheric carbonatite lenses are especially rich in niobium along the border, and in the larger bodies the mineralization is usually limited to some parts of the body, which seem to have relation to the brecciated zones.

In the central large carbonatite complex the mineralization follows certain steep brecciated zones running from north to south. The carbonatite rocks between these zones have very poor niobium content. The carbonatites of the area are chiefly limestones, but a certain Mg. metasomatismus has always followed the mineralization forming dolomite and some of the ore zones in the central area



Niobium bearing ore from the Söve deposits

consist chiefly of this mineral. The other chief accessory minerals in the carbonatites, besides the niobium minerals, are a fluorapatite, magnetite biotite, hornblende, pyrite, zircon and barite.

As mentioned, the niobium minerals belong to the pyrochlore groups and must be characterized as koppites. The composition and appearance vary within wide limits and within the same deposits, however, while the colour varies from light grey to brown and black, according to the variation in the iron content.

In the table opposite, based on anlayses carried out in the Söve mine laboratory, the low totals of the light coloured crystals are due to the alkalis which have not been determined. Spectroscopic analysis shows the presence of small amounts of rare earth elements, thorium, tantalum and uranium. The octahedral crystals of iron-rich koppies with more than 18 per cent FeO, are pseudomorphically altered to a mass of sub-microscropic rhombic crystals of columbite. Microscopic studies of thin sections show that the koppites nearly always have poikilitic inclusions of other minerals, especially, apatite and calcite.

Because of the different characteristics of the koppite minerals due to the different chemical compositions, ore dressing research has met with many difficulties. Ore dressing to-day is chiefly based on gravity concentration by tabling. The pyrite is removed by flotation and the magnetite by magnetic separation. After the solution of apatite in HNO_3—for use in the fertilizing industry—the rest of the concentrate contains about 50 per cent Nb_2O_5.

Current production amounts to about 15 tons 50 per cent Nb_2O_5 concentrate each month, but the plant is being expanded to give a monthly production of about 30 tons.

Mining is now limited to one of the marginal carbonatites, the Cappelen Dike, where about 1,500,000 tons of ore have been located. Another marginal carbonatite lens in the neighbourhood has been calculated to contain about 1,000,000 tons. The largest deposits, however, occur in the great central carbonatite body, but these deposits are not yet sufficiently developed to allow for assessment of their potential tonnage.

PERCENTAGE ANALYSIS OF CHIEF CHEMICAL COMPONENTS OF TYPES OF KOPPITE

	1	2	3	4	5	6	7
Nb_2O_5+ Ta_2O_5	59.4	65.0	61.4	64.4	62.4	64.4	74.0
TiO_2	4.16	3.9	4.48	4.8	3.97	8.0	3.60
SiO_2	—	—	1.41	—	1.99	—	—
FeO	0.60	2.31	3.76	4.1	18.70	18.7	20.70
CaO	18.35	15.00	15.80	16.1	7.58	—	—
MgO	0.46	0.29	1.30	1.8	0.82	6.1	0.89
BaO	—	—	—	—	1.90	—	—
Total	82.97	87.50	88.15	91.2	97.36	97.4	99.19

1 Brown coloured transparent octahedrons with sharp crystal outlines. Cappelen deposit.
2 Grey coloured octahedrons with resinous lustre.
3 Brown coloured, strongly deformed crystals with dull crystal faces. Cappelen deposit.
4 Light coloured translucent octahedrons. Cappelen deposit.
5 Black coloured octahedrons. Cappelen deposit.
6 Black coloured crystals of pseudomorphous columbite, without definite crystal outlines. Sharply poikilitic.
7 Sharp edged black coloured octahedrons of pseudomorphous columbite, after koppite. Very similar to magnetite in appearance. Tufte deposit.

As the mineralization of the ore zones often is very irregular, the diamond drill cores are not very representative as a basis of calculating the grade of the different ore zones. The located ores, however, according to assays of diamond drill cores, are estimated to contain 0.2-0.5 per cent Nb_2O_5.

REFERENCES

(1) W. C. Brögger: Das Fengebiet in Telemark, Norwegen. *Vitenskap. Selsk. Skr.* I No. 9, 1921.
(2) H. Björlykke: Norwegische Mikrolithmineralien, *Norsk. Geol. Tidskr.* B14, pp. 145-161 1934.

Single and Double Tube Core Barrels for Diamond Drilling Operations

To recover a sample of ground at depth it is necessary to utilize certain associated equipments in addition to the barrel designed to retain the extracted core. The following article describes in the main the types and applications of core barrels, but assumes that the advantages of the various barrels cannot be clearly explained without reference to the associated equipment.

Core bits take many shapes and forms. The cutting edge may be formed of whole diamonds, ranging in size from 200 stones per ct. up to about 2 ct., which are set in a predetermined pattern over the bit face and normally protrude about one-tenth of their size over the matrix. Alternatively, the bit may be impregnated with diamond fragments through the matrix.

The modern trend towards standardization of core drilling equipment has resulted in the development of four main sizes of bits. The smallest (EX) drills a hole of 1½ in. dia. and gives a core of ⅞ in. dia.; the largest (NX) drills a hole of 3 in. dia. and gives a core of 2⅛ in. dia. There are also standardized core bit sizes in the United States, Canada and Britain for core bits above 3 in. in dia., but these are not designated by symbols or letters and are used only for specialized applications.

To function efficiently a diamond bit must be designed in relation to drilling conditions. Among the factors to be considered are diamond size, grade, type, spacing and protrusion; type and profile of the matrix, and the method of clearing cuttings. By carefully positioning the diamonds in the cutting face, it is possible to provide a series of cutting edges so arranged that there is no space of uncut ground which could stand up proud and wear away the matrix. Stones of slightly larger size should be placed on the shoulders of the cutting edge. Those on the inner shoulders control the diameter of the core, while those on the outside shoulders ensure that the correct size of hole is drilled.

While drilling is in progress considerable pressure is exerted on the bit. The cuttings or tailings from the cutting operation are washed away by a strong current of water which is forced past the bit, also under considerable pressure. To assist the flow of water, the bit is provided with waterways, which are very carefully designed to ensure that no cuttings remain at the bottom of the hole after being detached from the rock. The flow of water also serves as a coolant for the bit.

FUNCTIONS OF DRILL RODS

The drill rods have two main functions to perform. They transmit rotation and pressure to the core bit and they also carry under pressure the cooling and flushing water down to the bit. The rods are made in various lengths, the most common being 5 ft. and 10 ft., but for the larger sizes 20 ft. rods are sometimes used. The water is usually supplied by a separate pumping unit of the reciprocating type,

having an output of between 20 and 40 g.p.m. at the relatively high pressure of 250 lb./sq. in.

In its simplest form the core barrel consists of a single tube and is designed to receive the core and protect it while it is being withdrawn from depth. At the bottom of the barrel is screwed the reamer shell, which has panels of diamonds so arranged that, if necessary, they will enlarge the hole cut by the core bit. Its function is to ensure that the hole is of standard dimensions and will permit the passage of the core barrel. It also prevents wandering of the bit and helps the driller to keep the hole straight.

EQUIPMENT EMPLOYED IN CORE SALVAGE

Also associated with the core barrel is the clever device known as a core lifter, which requires to be used in conjunction with a bit having a bevel wall. The core lifter operates by means of a tapered spring so arranged that it is out of action while the core is passing up the barrel, but moves downwards as soon as the operation is reversed and grips the core by being forced down the taper. The upwards pull causes the grip to tighten and the core is retained securely in the core barrel while being withdrawn.

In the early days of diamond drilling only straight wall core bits were used and the lifting of the core was entirely dependent on the skill and judgment of the operator. The driller shuts off his water and continues drilling until the heat generated has cemented the bottom of the core into the bit. Unless this operation is skilfully performed, there is considerable risk of damaging the bit or losing the core. Nowadays straight wall core bits are seldom used.

When a single tube core barrel is employed the cooling and flushing water is forced down the inside of the barrel, past the core that is being withdrawn, and through the reaming shell to the bit. It then passes across the face of the bit and makes its escape up the hole that is being drilled, carrying away the cuttings and cleaning the hole.

If the rock being drilled is of a hard and non-soluble nature, such as pegmatite or granite, the simplest form of core barrel can be used without any loss of core or damage to the bit. When drilling in friable or soluble minerals, however, means must be found to prevent the core from being washed away by the current of water. It then becomes advantageous to use a core barrel with a double tube. This type of core barrel is so arranged that the inner tube receives the core, while the flushing water travels downwards between the two tubes. Thus the water does not come into contact with the core until it reaches the bottom of the bit and flows across the face.

APPLICATION OF RIGID AND SWIVEL CORE BARRELS

There are two categories of double tube core barrels, known as the rigid and swivel types. In the former type the head is rigid and both the inner and outer tubes rotate with the drill barrel, the cone itself remaining stationary. When handling very weak or friable rocks it is undesirable that the centre tube should be turning. Manufacturers of core drilling equipment therefore developed a swivel type of double tube core barrel, in which the inner tube is mounted on a ball bearing and can remain stationary, while the outer tube rotates. In order to fit into the very small barrel the bearing must necessarily be very small, yet it is essential that the device should be robust enough to give dependable service under the most exacting conditions. This difficult design problem has been successfully solved.

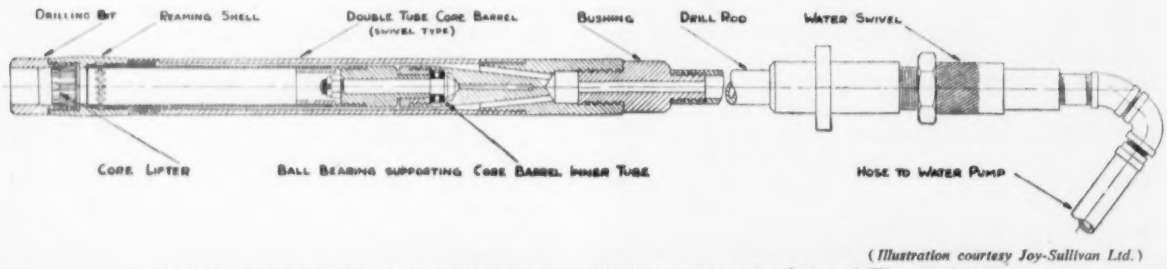
Even this refinement is not sufficient for certain applications, since the face of the core is still exposed to the flow of water and to possible damage by abrasion from the core-lifter. This difficulty, too, has been overcome, but owing to its complexity the very ingenious device developed for the purpose is necessarily limited to the larger diameters of core barrels. A double ball bearing is introduced and the inner tube is extended to the extreme bottom of the barrel into the bit itself. The core-lifter is carried in the barrel itself, and does not turn. The water again travels downwards through the annular space, but is discharged through channels in the wall of the bit right on to the cutting face, so that it does not blow across the face of the core. This type of equipment is known as a "bottom discharge" core barrel.

MODIFICATIONS OF PRACTICE

A few other modifications have also been introduced, which in certain circumstances, can add to the efficiency or economy of core recovery. When a 10 ft. core barrel is rotating in a hole which is being drilled through an abrasive substance, the wall of the outer tube may be subjected to considerable wear with consequent reduction in service life. For abrasive formations, it may, therefore, be expedient to use a core barrel which has been specially constructed to give maximum resistance to wear by cutting slots in the head and inserting strips of stellite, the outer tube being made of a hard facing material. Another refinement is to plate the bottom of the barrel with cadmium, again for the purpose of increasing wear resistance. While these modifications enhance the cost of the equipment, the additional outlay may well pay handsome dividends in longer life.

When drilling in minerals such as coal, salt or gypsum, core recovery may become very difficult, even when using the largest of the four main standard sizes. This limitation is leading to a demand for 3 in. or even 4 in. dia. cores by the National Coal Board and other large users of core drilling equipment. Core barrels of the swivel type with diameters up to 7¼ in. to give a 6 in. core are now in regular production.

Orders are sometimes placed for core barrels of large diameter for applications where speed is the prime consideration and core recovery is regarded as unimportant. In these circumstances the single-tube type of equipment would be preferred because of its greater simplicity and lower cost.



(Illustration courtesy Joy-Sullivan Ltd.)

The Sullivan Baby Turbinair core drill shows clearly the components of core drilling equipment

The Application of Aerial Survey Methods to Economic Development

Economic development on a world wide scale is currently proceeding at an unprecedented pace, although at present the comprehensive information as to economy and resources which is necessary to aid the development of an area is not always available. The article which follows, based on a paper entitled *The Application of Air Survey to the Economic Development of a Country* by T. D . Weatherhead, O.B.E., M.A., director and general manager, Hunting Aerosurveys Ltd., emphasizes the need for more detailed information and points out that an answer to the problem can be found in the application of airborne survey techniques. The article indicates the particular importance of aerial survey methods in connection with the mining industry.

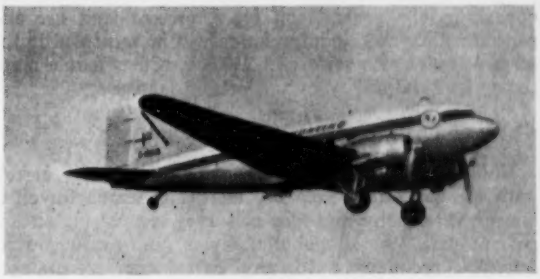
The industrial and agricultural revolution now taking place on an international scale demands a completely new approach to the problem of economic development. Yet, while the pace of that development is accelerated year by year the information upon which such development must be based is lagging behind, and a situation therefore exists where the economic development of large areas of the earth is being hastened for political, economic and social reasons while at the same time a growing doubt exists as to whether population and industrial output will outrun the agricultural and mineral resources currently known and available.

The statistics offered as proof of the possible danger of depleting the natural resources of the world should not be taken too seriously, because of the ignorance existing as to the extent of current and potential resources. For example, an analysis of the world position in regard to topographical maps was conducted by the United Nations in 1949, and a general statement published is probably reasonably accurate, showing that less than 2 per cent of the land areas of the world are mapped on a scale of 1 : 25,000 or larger despite the fact that such maps are essential for planning, development and administration. Further, it is doubtful if more than 25 per cent of the land areas of the world have reconnaissance maps of 1 : 300,000 or 1 : 250,000 scale or larger, compiled from aerial photographs or systematic ground surveys.

VALUE OF AERIAL SURVEYING

The survey showed, in addition, that with the possible exception of a few European nations and very limited areas in other countries, the status of surveying and mapping is nowhere adequate for the full economical development of natural resources. It was stated also that significance was attached to the fact that the nations in which the status of surveying and mapping had been highest for many years are now expending much larger sums in map improvement in proportion to national income and population than are the less well mapped nations. This, it is felt, indicates the appreciation of higher quality maps where these are available.

Soil surveyors in Iraq drilling for samples



Dakota aircraft in flight showing towed magnetometer detector head underslung amidships

Aerial survey practice—used in its widest sense as the application of airborne exploration method—has an important role to play in the production of topographical maps. The first requirement in an unmapped area is obviously to obtain some knowledge of the topography. As has been described in previous issues of *The Mining Journal*, vertical photography is carried out with a specially modified and equipped aircraft, the flying height of the aircraft and the scale of photographs being determined by their subsequent use.

In some areas it may not be necessary to go to the additional expense of preparing an accurately-scaled topographical map. A photographic mosaic made up from the vertical photographs can provide a satisfactory base for recording resources inventory information. The helicopter and airborne electronic aids are both being used to hasten the essential ground survey work involved in any mapping.

Land use planning should operate in three main phases in each of which the use of aerial photographs is of major importance. First, essentially a reconnaissance phase, is the mapping of present land use. The second phase is the recognition and mapping of geological features together with soil and vegetation units after which an assessment is made of existing natural resources. The third phase involves an assessment of how the land could be used or developed.

LAND PLANNING

A good example of a resources survey now in progress is that being carried out in Western Pakistan. In order to assist the economic development of Pakistan, the Canadian Government agreed to carry out a resources survey of Western Pakistan as part of Canada's contribution under the Colombo Plan. The work was divided into two parts, a preliminary geological survey of Baluchistan, and a soils and land use survey of the Indus Valley. The whole area, 300,000 sq. miles, was photographed at 1/40,000 scale and mosaics at 1/40,000 made of the whole area.

The first step in the geological survey was the study of all available data, its classification and plotting into the mosaisc. The second step was the geological interpretation of the photographs. Greatest attention was paid to major

geological structures as most economic deposits are related directly or indirectly to structure. The geological parties then carried out their examination, recording their data in field notes and on the mosaics. Using these techniques, a geological map at a scale of 4 miles to 1 in. (1/250,000) will be produced of 123,000 sq. miles in four years after the completion of the photography. A report will be submitted recommending the most worthwhile areas for detailed attention and the most feasible steps to take on their development.

In the Indus Valley an area of 140,000 sq. miles, the purpose of the survey is to provide reconnaissance data concerning the general soil types, present land use and general salinity. This information will be presented in the form of maps at a scale of 1/250,000, with separate maps for agricultural soil types and present land use.

SURVEYING FOR MINERALS

Unlike agricultural resources, minerals in the earth's crust are not renewable. The increasing search for oil is one where airborne methods of survey are playing an important part. Aerial photography is now considered an essential preliminary to any exploration programme Stereoscopic photo geological interpretation of the photographs can reveal not only the topography but also much of both regional and detailed geological structure. Dip and scarp slopes are often visible where hard bands of rock have resisted erosion, and the trend lines of strike and direction and amount of inclination of the dip can be recorded. Localities of geological interest can be rapidly selected for examination and sampling by field parties. Even if no surface geology is visible, the preparation of an accurate topographical map from the photographs can save a great deal of time on the ground.

Airborne magnetometer surveys are being used to an increasing extent in the reconnaissance stage of exploration. Many geological structures favourable to oil are underlain by basement uplifts and thus the detection of the depth and form of the basement surface is one of the principal applications of the magnetic method of oil prospecting. The igneous and metamorphic rocks that compose the basement are usually more magnetic than the over-laying sedimentary types, and where they approach nearer to the surface an increase in magnetic intensity results.

One of the main values of the aeromagnetic method is to isolate areas of interest in which detailed investigations can be made by other means. Recent work over dense jungle country has shown amazing correlations between the results obtained from the more detailed work of the gravity and seismic parties.

TYPICAL SURVEYS

Amongst the operations carried out by Hunting Aerosurveys Ltd. and Hunting Geophysics Ltd. during 1954, several of those dealing more particularly with the search for minerals stand as typical examples of the methods employed in aerial surveying practice.

Mining activities have given rise to an aeromagnetic survey of 1,313 sq. miles in the Philippines, a similar survey of 234 sq. miles in Malaya, a photographic and aeromagnetic survey of 1,600 sq. km. and 1/25,000 scale mosaics in Norway and mosaics in 15,000 sq. miles at 1/30,000 scale from R.A.F. photography in Northern Rhodesia. In addition, colliery development in the United Kingdom was aided by the photography of 710 acres and the completion of plans at 1/2,500 with 2 ft. contours in the West Midland Division of the National Coal Board.

Aerial survey methods were widely used by the companies in oil exploration last year. In British Somaliland mosaics at 1/40,000 scale were prepared from R.A.F. photographs of 5,000 sq. miles. In Iraq the photography of 160 sq. miles was completed and mosaics at 1/10,000 scale prepared, while photography of 30,000 sq. miles and mosaics at 1/40,000 scale were completed in Oman. Aeromagnetic surveys were carried out in Thailand (15,444 sq. miles) and Assam (10,000 sq. miles), while in Libya photography of 560 sq. miles was accomplished together with the aeromagnetic survey of 175,750 sq. miles.

In addition to these activities, work was completed in connection with power, housing, and industrial developments, as well as irrigation and reservoir surveys.

A TECHNICAL DEVELOPMENT

A new development in aerial surveying has been the installation in one aircraft of three separate electronic systems of surveying. Until recently technical difficulties prohibited the installation of all three in a single aircraft

The three devices are the airborne magnetometer which records variations in the earth's magnetic field and aids geologists in the search for iron, oil, asbestos, titanium and nickel; the scintillation counter, an airborne instrument that gives clues to the presence of uranium in the earth; and the electromagnetic detector which can directly locate sulphide bodies that may contain copper, lead, zinc or nickel.

The electromagnetic detector requires a transmitting coil energized with an alternating electric current to surround it with an electromagnetic field. This field induces electric currents in any conductor within reasonable range (e.g. a sulphide body, water, moist overburden), thereby surrounding the conductor with a secondary electromagnetic field differing from the first in amplitude and phase. Such differences in amplitude and phase are utilized by electromagnetic systems to detect the presence of the secondary field; at the same time the electromagnetic detector also measures conductivity, thereby differentiating between poor conductors such as water and better conductors such as sulphide bodies.

Under favourable terrain conditions—over ordinary wet outcrop, for instance, rather than thick wet clay—the primary field will penetrate to depths of 300 ft. below the earth's surface and detect sulphide bodies. Electromagnetic and magnetometer findings complement each other neatly, the magnetometer giving a regional picture of geology and structure and also revealing presence of magnetic mineral concentrations, while the electromagnetic detector indicates concentrations of sulphide bodies which may or may not be susceptible to detection by the magnetometer.

MEETING THE CHALLENGE

An interesting paper recently read on "Mineral Resources Strategy" by D. A. Oliver to a conference organized by the Department of Scientific and Industrial Research, pointed out that the geological survey work carried out by Government Departments stops at a relatively early stage and that—on the whole—British mining interests have shown caution in continuing the investigations owing to a variety of reasons. The paper recommended the establishment of an Independent Committee of Enquiry involving several Government Departments.

It was also intimated that a study should be made as to whether the present speed of geological exploration in the Commonwealth is sufficient to meet the estimated needs of the industry during the next decade, and whether greater use could not be made of new techniques—particularly airmorne methods—to reduce the time spent in ground survey operations.

TECHNICAL BRIEFS

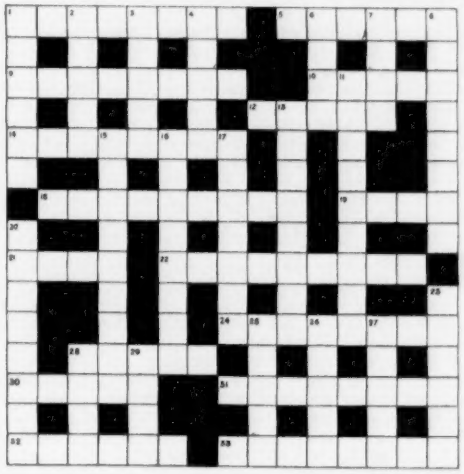
Frozen Mercury in Casting of Precision Parts

Larger and more complex precision parts can now be produced in a wide variety of metals through the use of a frozen mercury casting method, according to the Mercast Corporation, United States, which reports that this development makes precision casting possible "to a degree never before achieved by conventional procedures".

Industrial Laboratories points out that the key to the process lies in the ability of frozen mercury to be booked or adhere to itself on contact with slight pressure. The method calls for pouring mercury into the die, which is divided in two or more sections. The whole unit is then submerged in a dry ice-acetone bath at temperatures around minus 100 deg. F. to freeze the mercury. Following this step, the assembly is removed from the bath, booked to make a single frozen mercury pattern that is then extracted from the die, and dipped into a series of slurries to form a ceramic shell around it. Returning to room temperature, the mercury melts and is run out for subsequent reuse. The thin shell mould is fired to strengthen it and the metal is poured.

The advantages of this ceramic mould include excellent surface finish, closer tolerances in the metal casting, thin wall castings and the fact that the mould does not react with molten materials. This factor is important in casting of highly reactive metals. These moulds have been successfully employed in the casting of titanium, it is reported. Molten titanium, a highly reactive metal, will react with all known refractory materials and to date, no substance has been found suited for crucibles used in melting titanium.

The technique is now being used industrially in making such parts as wave guides and other radar components, turbine blades and other jet engine parts and piston engine parts. Other products which can utilize this method are pneumatic piston components, electric generator brackets, bearing supports and glass mould dies.



'UNICONE' CROSSWORD No. 4

ACROSS.—1. Spry maid at Gizeh (8). 5. Mix 6 with an afterthought in writing (6). 9. Moulting time for fledglings? How depressing! (8). 10. Your years are numbered from here (5). 12. "Peace!—the ----'s wound up." Shakespeare (5). 14. Could it be one of the 3D's? (8). 18. O Rude name! Charmed I'm sure (9). 19. Not another name for aconite but it might be (4). 21. Not necessarily nylons (4). 22. Reverse up here, not back round (9). 24. Vibrated with emotion (8). 28. In sea but not seaweed (5). 30, 31. Splash about here as you please. It's a mod. con. (5, 8). 32. Salt water mixed up in the motor (6). 33. Fish fit for a queen (8).

DOWN.—1. Hawk (6). 2. The mountain ash (5). 3. It sounds a sort of Scottish parrot (5). 4. Mr. Miller's forename very likely (5). 6. Leap for it (4). 7. A "B" will make it flower (4). 8. Held cues in a detailed list (8). 11. This produces interest we hope (9). 13. Bowler hats and crash helmets are (4, 4). 15. Presumably Omar's favourite in the vegetable kingdom (9). 16. There were a dozen of them (8). 17. Just too much of a good thing (7). 20. Not a nervous disorder brought on by excessive ringing up (8). 23. He pays perchance (3, 3). 25. Courted if sweet (5). 26. This is in Godlike vein (5). 27. Set free (5). 28. It's bitter (4). 29. Just a notion required here (4)

Solution on page 422

New Uses of Isotopes

Some of the newest ways in which atomic energy is being harnessed for industry were demonstrated in Birmingham from February 14 to 26 when a special exhibition was held at the Birmingham Exchange and Engineering Centre. Technicians from the Isotope Division of the Atomic Energy Research Establishment at Harwell devised the exhibition, and a number of industrial firms who manufacture equipment for work with radioactive isotopes also took part. The United Kingdom is now the largest supplier in the world of these radioactive materials and the exhibition was mainly concerned with the many ways in which they can be used for industrial purposes.

Among the techniques demonstrated was the use of isotopes as substitutes for X-rays in the examination of castings, welds and forgings for their soundness and freedom from blowholes and cracks; thickness gauges which can maintain a continuous measurement of thickness of metal sheet and plate, linoleum, paper, etc., and the thickness of plating, paint or lacquer coatings applied to metal surfaces; the measurement of leakage from water pipes and fuel lines—a method which has contributed to the reduction of fire hazard in aircraft—and improved methods of checking the efficiency of liquid or gas filters. An interesting working demonstration showed how wear on bearings or moving parts can be measured in a few hours without having to dismantle an engine. Previously, many thousands of hours of running were necessary before wear could be measured by weighing or by micrometry.

Further news in the development of atomic energy is that the United Kingdom Atomic Energy Authority has lent to the Science Museum a large working model showing the B.E.P.O. atomic pile, the larger of the two pioneer atomic piles set up at Harwell. This pile went into operation in July, 1948, and is used for research purposes and for "cooking" the radioactive isotopes which are now so widely used in medical research and treatment, in agricultural research and in industry.

Copper on Adhesive Coated Foil

An increase in the use of electrolytic copper for adhesive coated copper foil has been predicted by Dr. S. J. Karwan, Permacel Tape Corporation, United States. The increased use of copper in adhesive coated copper foil is attributed to the expansion of facilities and increased production of leading laminators engaged in printed circuit work, according to *American Metal Market*.

One of the largest of current electrical and electronic developments is based on the miniaturization of equipment, that is, drastically reducing the size of the finished electrical product. Printed circuits have helped to achieve this end by reducing an entire electrical circuit to a compact copper wire printed circuit which can be used where space is at a premium.

Originally, printed circuits were manufactured by joining an electrolytic copper sheeting to phenolic board with an adhesive film such as Permacel 18, under specific heat, time and pressure conditions. The circuit was then printed on the copper and etched in an acid bath which ate away the unwanted portions of the copper. The result was a flat copper wire circuit rigidly laminated to the phenolic panel. Connections were all soldered simultaneously by dipping the entire unit into molten solder. These circuits were installed in all types of electronic devices such as radio and television sets, hearing aids, etc.

Techniques of Titanium Welding

Problems encountered in welding titanium sheet metal have been eliminated by new techniques developed by Marquardt Aircraft Company, United States, according to conclusions contained in a technical paper prepared for the Aircraft and Rocketry Panel of the American Welding Society.

The paper outlined the Marquardt method of fusion welding utilized in the fabrication of an afterburner shroud for a turbojet engine. The chief advantage of the new technique is that it produces welds which are extremely ductile and which will withstand the most severe type of service. The Marquardt welding technique eliminates the need for weld bead grinding, which when applied to titanium welds often resulted in embrittlement of the metal due to overheat from the grinding wheel. Elimination of the grinding operation resulted in considerable improvement in the quality of titanium parts.

METALS, MINERALS AND ALLOYS

COPPER.—Copper has continued extremely tight in the United States at 36 c. per lb, and no relief is now looked for (excepting perhaps from a strike in one of the big consuming industries) before the second half of the year at the very earliest. On the other hand there is considerable nervousness lest a strike should occur on the copper producing side. The wildcat strike at Phelps Dodge, Laurel Hill refinery which began on April 5 was settled on April 6 and the strike at Douglas, Arizona which began on April 7 was settled four days later.

Considerable stir has been caused by a rumour emanating from London that West Germany was to get 22,000 tons of copper from the United States. New York trade circles said that this was impossible and that export licences for such a total could never be granted in the present stringency without a widespread outcry. The Commerce Department subsequently revealed that licences for over 22,000 tons had actually been issued in the first quarter for export to West Germany, but that this amount was probably not shipped. The reason given was that exporters would probably find difficulty in getting the copper even if they had the licences. This is a curious explanation, to say the least. Granting export licences for unavailable copper simply means importing the higher European price level. The whole story has not yet been told.

Meanwhile, it has been announced by the Board of Trade that some 45,000 tons of government owned copper is being released for consumption. Something approaching half this amount has already been made available to Rhodesian producers and their sales agents and the remainder is to be disposed of in association with the trade. Various reasons have been suggested for this announcement at this time. Certainly any extra copper will be welcome in the next few weeks before the effects of the Rhodesian strike begin to wear off, and the Government have probably had this in mind. From the taxpayer's point of view this is quite a profitable time to sell, though it is not the peak of the market and the announcement has lowered values further.

It is hard not to accept the view that the Government is not so much after a bargain price (with a whopping above the line budgeting surplus it is not short of cash) as after a lower price. A substantially lower copper price level would do an enormous amount of good to the balance of payments problem as a glance at Trade and Navigation Accounts will show. In the first two calendar months of 1954, the United Kingdom imported 1,187,049 cwt. of copper; in the comparable period of 1955, 1,618,339 cwt.; the value of this copper jumped, however, from £13,410,013 to £23,647,188. Moreover, the bulk of the increase in volume of copper imports came from the U.S.A., Chile and "other countries," and must, one way or another, have involved heavy dollar expenditure—and the balance of payments crisis is a reappearance of the old familiar dollar gap.

In January-February, 1954, imports from U.S.A., were 40,929 cwt. and from Chile nil; in 1955 they have become 170,421 and 129,154 cwt. respectively. Payments in these periods have jumped from £512,773 to £2,491,704 in the case of U.S.A., and from nil to £1,831,915 in the case of Chile. In other words it may be assuming too much to say that the Government is trying to depress copper prices but it could certainly be said that, if prices are in consequence depressed, nothing will benefit quite so much as the United Kingdom's balance of payments.

Mr. E. S. Hann, treasurer of Kennecott Copper, has forecast a highly satisfactory 1955 for copper and has said that during 1956 and immediate subsequent years demand for copper would about equal available supplies. Mr. Lenz, president of Kennecott Sales, said he believed that providing there are no major strikes copper could be held at 36 c. per lb. He believed that a price of 30 c. might be sufficient to maintain production around present levels. "I do not think, however, we will see a price in the 20 c. range except for maybe occasional temporary dips."

LEAD.—The New York lead market, which has been quite firm in the last few weeks, turned substantially stronger on the announcement of a price increase for zinc while the continuing strength of copper also lent support. Lead stocks may now be down to no more than about six weeks' supply since on March 1 they stood at 52,734 tons as against 69,908 tons a month earlier.

Yet another bill has been introduced in the House of Representatives seeking to impose a tax of 2 c. per lb. on lead and zinc imports in certain circumstances. The bill has been introduced by Congressman Edmondson (D-Oklahoma). *Reuter* reports that tax would be applicable during a week in which the domestic market prices for these metals were below the adjusted base price of these metals for such a week. For taxation purposes, the adjusted base price of lead for any week would be an amount bearing the same ratio to 15 c. as the : (a) Bureau of Labour Statistics index of wholesale prices for all commodities other than farm products and processed foods for the first calendar month of the quarter preceding the quarter in which such a week begins, bears to (b) such index for March, 1955. The average market price for lead would be that of the second preceding week as published by the Secretary of Commerce This is a rather fancy variation of a sliding scale. It is interesting to note that zinc will be treated similarly except that the base price would be the same ratio to 13½ c. as (a) to (b).

The Export-Import Bank has granted a credit of $50,000 to the Compania Minera de Huehuetenango, S.A., a Guatemalan mining company. The bank said the company would use the money to purchase United States materials, equipment and technical services to resume the mining and processing of lead ore. The mine suspended operations in December, 1953. The company would repay the credit over a period of two and one-half years and would pay interest of 6 per cent per annum.

TIN.—Tin has continued its rather aimless course in New York although the demand for tinplate has given an underlying steadiness. There seems little doubt that second quarter tinplate demand on both domestic and export account will exceed that of the first quarter and that was surprisingly good. The possibility of labour problems in the steel industry is the only foreseeable cloud.

The Belgian Senate has now ratified the I.T.A. but the move aroused little comment. It is confidently expected that enough consumers will fall into line so that Belgium's 14 consumer votes are not really urgently needed; and it has long been realized that the producers' vote can only be gathered in with Indonesian help and that seems as far away as ever. It is fairly clear that Indonesia is hanging back to see what happens to the Texas smelter—indeed it is impossible to think what alternative reason there could be.

The Indonesian-Texas smelter situation is discussed in recent bulletins from A. Strauss and Co. and Nathan Trotter and Co. with interesting divergencies of interpretation. A. Strauss and Co. argues that Indonesia is apparently regarding the Texas smelter and the I.T.A. as "mutually exclusive alternatives" and that she would find a renewed contract for providing the Texas smelter with sweeteners more advantageous than any foreseeable production allocation under I.T.A. The bulletin also argues that America is, in effect, deliberately stalemating the Indonesians by withholding a Texas decision—"while America can afford to be in no hurry about the smelter it is doubtful whether Indonesia is in the financial position to hold on to her ores indefinitely".

Why is America doing this? "Until recently it had been almost universally assumed that the American Government would decide the fate of the smelter independently of any outside consideration beyond her own strategic necessities. It would now appear that the Senate Banking and Currency Committee may be prepared to let the smelter lapse if by doing so it would not cause too much difficulty in the tin world; and this could be guaranteed only if there were a tin scheme to carry the burden of the world's surplus. What is more, America's reluctance to show her hand could easily be construed as a direct hint to producers to join the Tin Agreement without further delay."

Nathan Trotter and Co. puts quite another construction on the delay in publishing the investigating committee's report. "In our last report we said it is confidently expected that our so-called leaders would have their way, i.e. continuation of the smelter. A somewhat different light has been placed on this situation following the announcement that another extension, this time till April 30, has been granted the proponents of continuation. In view of this development, it is quite obvious that Senator Johnson's (D-Texas) investigating staff has turned in a report that does not fit in with his plans and desires. We are advised that this report was turned in a week ago. What the Senator's next move will be, we don't know, but it would be most interesting and perhaps embarrassing to him if the trade papers were to smoke out and publish the report".

On the whole, and making allowance for political considerations, Nathan Trotter's version smells a bit nearer the truth than that of A. Strauss. A. Strauss's case assumes that the American attitude to the smelter is made up. That may well be true as far as the Administration is concerned. But the investigations have not yet reached the stage at which the Administration can get a grip of them. They are still at the stage at which the in-

terests can jockey for position and this fact lends colour to the Trotter viewpoint.

It is reported that Mr. Tan Tuan Boon, secretary of the National Union of Mineworkers, has recommended to the Central Executive of the Malayan Trade Union Council that the Malayan tin industry should be publicly owned. This is, of course, still an extremely remote possibility but it is worth recalling the recent elections at Singapore and their return of a Socialist party as the leading political group.

Malayan tin exports in March reached 7,589 tons; 5,178 went to the United States. February shipments were 5,615 tons.

ZINC.—Prime Western Zinc in the U.S.A. advanced generally last week to the level of 12 c. per lb. East St. Louis which had been set by the St. Joseph Lead Company. At the new price, however, demand eased following a last bout of "bargain" buying from those still willing to sell at 11.50 c. There is no reason to suppose that zinc demand is exhausted however and consumers should quickly re-enter the market when they have recovered their breath.

Meanwhile there has been much printing ink spilt on the subject of lead-zinc stockpiling. First it was said that the United States Government would shortly announce a new lead-zinc stockpiling programme; later it was said that, since the targets of the 200,000 tons of lead and 300,000 tons of zinc had not been reached there was no reason to suppose the programme would end; yet another "spokesman" said that June 30 was a "mythical" date. In fact, June 30 was a very real date and the stockpiling targets were permissive and not absolute. So that the flurry probably means that stockpiling will continue; certainly the trade thinks this, providing lead does not go above 15 c. or zinc above 13 c. per lb.

What is not clear, however, is the connection between all this forecasting and the statement by Mr. Felix Wormser that a new lead-zinc policy was on the way. Offerings to the stockpile have been getting smaller recently as commercial demand has picked up so that it is not impossible that stockpiling may continue alongside some new assistance programme.

Although zinc stocks fell at the end of March for the tenth successive month the extent of the fall was only slight. Smelter stocks fell by 5,328 tons to 90,837 tons (against 201,000 at the end of March, 1954), whereas in February stocks had fallen by 21,000 tons. March zinc production at 89,179 tons was a new record as was the daily average rate of 2,877 tons. It is said, however, that this rate is only being achieved at the cost of cutting stocks of concentrates so that this should fairly quickly bring its own corrective. March deliveries were 94,507 tons; 79,720 to consumers, 1,828 exported and 12,959 tons for Government account.

CHROME.—The first shipments of Turkish chrome are now reported to have been made in the deal involving the export of 100,000 tons of chrome in exchange for American grain. A number of enquiries for Turkish chrome are reported to have been made from other countries so far without success as the Turkish Government still appears to be holding out for prices above world level.

Turkey's first ferro-chrome concentrating plant will, it is now believed, be ready to start production in two years. An agreement has been signed in Ankara between the Eti Bank and the French concern of Pechiney for the erection of the plant which is expected to cost $4,640,000. The plant will use a Pechiney process to produce about 8,000 tons annually of ferro-chrome from 25,000 tons of chrome ore. The plant will also produce about 4,000 tons per year of calcium carbide.

Total output of chrome in New Caledonia last year is reported at 85,000 tons averaging 52 per cent metal against 121,000 in 1953. The States took 27,000 tons of this.

The London Metal Market

(From Our Metal Exchange Correspondent)

The only item of interest during the shortened period under review is the announcement by the U.K. Government of their intention to sell 45,000 tons of electrolytic copper over the remainder of this year. This news caused a sharp decline in the price at the opening on Wednesday morning, but the market remained steady for the rest of the day.

Apart from the official statement which said that a part of the tonnage had already been sold back to the Rhodesian producers' agents and that discussions were taking place with the trade about the disposal of the balance, the Chairman of the Committee of the Metal Exchange announced that the balance was more than 50 per cent of the total tonnage involved. He added that the discussions which were being entered into by the Board of Trade with the London Metal Exchange and the British Non-Ferrous Metals Federation did not envisage the reinstatement of a Government Broker.

As the tonnage in question is the balance of the Government's trading stocks and is entirely independent of any tonnages held in the national stockpile, it is to be assumed that the disposal will probably take the form of asking for tenders following the method normally adopted in disposing of surplus stores and equipment. It is further assumed that no definite decision has yet been taken about whether this tonnage shall be available for export or whether it will be confined to home consumption, but the general impression at the moment is that export will be permitted and that British consumers will therefore have to meet competition, especially from Germany.

The fall in the price can only be regarded as healthy, and there is every hope that the copper market will now be maintained at a level comparable with that existing in the States although substantial premiums will continue to be paid for nearby metal at least for delivery up to the middle of the year.

On Thursday morning the Eastern price for tin was equivalent to £728½ per ton c.i.f. Europe.

Closing prices and turnovers for four market days are given in the following table:—

	April 6		April 14	
	Buyers	*Sellers*	*Buyers*	*Sellers*
Copper				
Cash	£351	£352	£305	£305½
Three months	£344	£345	£300	£300½
Settlement	£352		£305½	
Week's turnover	3,675 tons		9,050 tons	
Tin				
Cash	£717	£717½	£715½	£716
Three months	£718	£718½	£716	£717
Settlement	£717½		£716	
Week's turnover	545 tons		250 tons	
Lead				
Current half month	£104½	£105	£104½	£104½
Three months	£103½	£104½	£104½	£104½
Week's turnover	1,950 tons		2,725 tons	
Zinc				
Current half month	£89½	£89½	£90	£90½
Three months	£88½	£89	£88	£88½
Week's turnover	5,275 tons		2,650 tons	

OTHER LONDON PRICES — APRIL 14

ANTIMONY

English (99%) delivered, 10 cwt. and over .. .. £210 per ton
Crude (70%) .. .. .. £200 per ton
Ore (60% basis) .. .. 22s./24s. nom. per unit, c.i.f.

NICKEL

99.5% (home trade) .. .. £519 per ton

OTHER METALS

Aluminium, 99.5%, £163 per ton
Bismuth (min. 2 cwt. lots) 16s. lb.
Cadmium (Empire) nominal
Chromium, 6s. 5d./7s. lb.
Cobalt, 21s. lb.
Gold, 250s. 7d.
Iridium, £30/£32 oz. nom.
Magnesium, 2s. 4d. lb.
Manganese Metal (96%-98%) £255/£265 according to quantity
Osmiridium, £40 oz. nom.
Osmium, £30 oz. nom.
Palladium, £6 5s./£6 15s. oz.
Platinum, £27/£27 15s.
Rhodium, £41
Ruthenium, £16 oz.
Quicksilver, £108 10s./£109 ex-warehouse
Selenium, 43s. nom. per lb.
Silver, 75¼d. f.oz. spot and 75¼d. f'd
Tellurium, 15s./16s. lb.

ORES, ALLOYS, ETC.

Bismuth .. .. 30% 5s. lb. c.i.f.
20% 3s. 3d. lb. c.i.f.

Chrome Ore—
Rhodesian Metallurgical (semi-friable) 48% £13 per ton c.i.f.
,, Refractory 45% .. £13 per ton c.i.f.
,, Smalls 42% .. £10 2s. 6d. per ton c.i.f.
Magnesite, ground calcined .. £26-£27 d/d
Magnesite, Raw .. .. £10-£11 d/d
Molybdenite (85% basis) .. 105s. 3d.-108s. 1d. per unit c.i.f.
Wolfram and Scheelite (65%) .. 207s./212s. c.i.f.
Tungsten Metal Powder (98% Min. W.) .. 17s. 9d. nom. per lb. (home)
Ferro-tungsten (80%-85%) .. 14s. 9d. nom. per lb. (home)
Carbide, 4-cwt. lots .. .. £37 6s. 3d. d/d per ton
Ferro-manganese, home .. £53 17s. 6d. per ton
Manganese Ore Indian c.i.f. Europe (46%-48%) .. .. 76d./78d. per unit
Manganese Ore (38%-40%) .. 64d./66d. per unit
Brass Wire .. .. 2s. 11¾d. per lb. basis
Brass Tubes, solid drawn .. 2s. 4½d. per lb. basis

THE MINING MARKETS

(By Our Stock Exchange Correspondent)

The week under review includes the Easter holiday period which is traditionally a quiet time for Stock Exchange business, but overall, the trend was steady to firm.

Among mining shares, quiet conditions prevailed but there was a selective improvement in Kaffirs on Wednesday. The demand for some of the best finance house issues was maintained and this was particularly noticeable in African and European, Consolidated Goldfields, Central Mining and Union Corporation. Johannesburg Consolidated again suffered from the disappointing returns from Freddies Consolidated and Randfontein. There was some interest in Vereeniging Estates. It is possible that the new taxation laws in South Africa may encourage the Board in a more generous dividend policy.

Among individual Rand mines, some of the older properties, such as Durban Deep, improved. It is thought that the effect of the better native labour situation will shortly be shown in the returns. Far West Rand issues were neglected and prices generally lost ground. Disappointment with the Randfontein results caused a fall in the share price. Although the company made increased profits from uranium, this was offset to a considerable extent by lower gold production. Another dull counter was Western Reefs. These shares have declined steadily for some time past. The improved returns from West Driefontein failed to inspire the shares which drifted lower.

In the Orange Free State, the March loss by Freddies Consolidated caused further dwindling and Free State Geduld, which for the past few weeks has been the controlling factor in this market, initially declined also. Later, bargain hunters brought about some recovery in these shares. Loraine were steadier at the level reached last week. Market rumours suggest that this property will shortly start gold production. Orange Free State Investment Trust shares were affected by the general trend, but, following Free State Geduld, hardened on Wednesday. The overall gloom affecting this section also lowered President Brand and St. Helena, two mines which produced satisfactory March figures.

West Africans remained very quiet but market circles continue to regard the Ashanti report in a favourable light and the chairman's statement at the meeting will be awaited with interest. Progress by Ariston and Western Selection caused some quiet buying of these shares.

The exceptional quarterly diamond sales by De Beers caused considerable interest, although the exact extent to which De Beers is committeed in Freddies Consolidated and other marginal Orange Free State properties is still not known. Other leading diamond companies were favourably affected by this turn of events.

Coppers, in the earlier part of the week, were strong and recorded good all round gains. Messina, at one time, touched £9 and Chartered in their new form were quoted at over £3 early on Wednesday. Later on this day the £30 fall in the metal price caused a general setback. Prices mostly closed a little above the lowest levels.

Eastern tin shares were mostly erratic due to the uncertainty concerning the metal situation. Market conditions remained quiet. Three of the dredges operated by Tronoh ceased operations for three weeks during March due to labour trouble but are now working again. Tekka-Taiping, which last week jumped following the total distribution of 12½ per cent for the year against 2½ per cent for the previous year, eased on lack of sustained interest. In the Nigerian section, there was little of interest to report but London Tin encountered some quiet buying, as also did British Tin Investment. Beralts jumped a further 1s. 6d.

In the lead/zinc market, conditions were also quiet but leading shares mostly gained the turn. Consolidated Zincs were an outstanding feature Later, the fall in copper prices created uncertainty in all base metal markets and this section suffered from this factor. Mount Isa, which also produces copper, was particularly affected.

In the miscellaneous base metal section, interest was principally centered upon asbestos producers but Consolidated Murchison and Wankie were also bright spots.

There was a sharp renewal of interest in Canadian base metal mines and all leading issues went ahead. Hollinger were particularly firm due to their iron ore interests.

FINANCE	Price April 13	+ or — on week
African & European	3⅞	+⅛
Anglo American Corpn.	7⅛	—⅛
Anglo-French	20/7½	
Anglo Transvaal Consol.	28/1½	—7½d
Central Mining (£1 shrs.)	41/9	+6d
Consolidated Goldfields	58/1½	
Consol. Mines Selection	37/6XR	—1/3
East Rand Consols.	2/9	+3d
General Mining	5½	—⅛
H.E. Prop.	9/7½	
Johnnies	38/-	—1/6
Rand Mines	3¼	
Rand Selection	42/6	—7½d
Union Corporation	43/-	—6d
Vereeniging Estates	4⅛	
Writs	41/3	—7½d
West Wits	37/9	—9d
RAND GOLD		
Blyvoors	29/3	—9d
Brakpan	6/6	—3d
Buffelsfontein	34/6	
City Deep	12/-	—6d
Consol. Main Reef	19/6	—6d
Crown	45/7½	
Daggas	58/1½	—7½d
Dominion Reefs	35/6	—9d
Doornfontein	29/-	—1/-
Durban Deep	33/9	+1/3
E. Champs	9/-	
E. Daggas	10/6	
E. Geduld (4s. units)	28/3	—3d
E. Rand Props	3	—⅛
Geduld	3½	
Govt. Areas	10/3	—3d
Grootvlei	20/6	—3d
Hartebeestfontein	32/-	—6d
Libanon	8/1½	—1½d
Luipaards Vlei	23/3	—6d
Marievale	21/3	
New Kleinfontein	8/6	
New Pioneer	15/3	—6d
Randfontein	63/-	—1/6
Robinson Deep	16/9	+6d
Rose Deep	13/3	
Simmer & Jack	4/1½	
S.A. Lands	22/6	+7½d
Springs	2/7½	
Stilfontein	26/3	—4½d
Sub Nigel	36/10½	
Vaal Reefs	31/-	—6d
Van Dyk	4/-	
Ventersdorp	12/-	
Vlakfontein	16/9	—6d
Vogelstruisbult	34/9	—6d
West Driefontein	5⅛	—⅛

RAND GOLD contd.	Price April 13	+ or — on week
W. Rand Consolidated	43/9	
Western Reefs	43/3	—1½
O.F.S. GOLD		
Freddies	4/-	—3d
Freddies Consolidated	6/-	—1/-
F.S. Geduld	4⅛	—⅛
Geoffries	16/6	—9d
Harmony	35/9	+3d
Loraine	10/6	
Lydenburg Estates	20/-	—7½d
Merriespruit	12/1½	—1½d
Middle Wits	16/6	—9d
Ofsits	3⅛	—¼
President Brand	69/6	—1½
President Steyn	40/6	—9d
St. Helena	28/6	—3d
Virginia Ord.	14/-	—6d
Welkom	21/-	—9d
Western Holdings	4⅛	—⅛
WEST AFRICAN GOLD		
Amalgamated Banket	2/4½	
Ariston	6/1½	
Ashanti	22/-	
Bibiani	4/10½	
Bremang	1/6	
G.C. Main Reef	3/3	—1½d
Kononga	2/7½	
Lyndhurst Deep	1/3	
Mariu	1/-	
Taquah	2/9	+1½d
Western Selection	8/7½	
AUSTRALIAN GOLD		
Gold Mines of Kalgoorlie	12/-	
Great Boulder Prop.	9/1½	
Lake View & Star	15/6	
Mount Morgan	19/3	
North Kalgurli	7/3	
Sons of Gwalia	5/-	—3d
Western Mining	10/-	
MISCELLANEOUS GOLD		
Cam & Motor	8/3	
Champion Reef	4/-	
Falcon Mines	7/3XD	+3d
Globe & Phoenix	26/-	
G.F. Rhodesian	6/3	
Motapa	1/6	
Mysore	5/9	+9d
Nundydroog	6/6	
Ooregum	4/4½	
St. John d'El Rey	12/9	+3d
Zams	52/6	+1/9

DIAMONDS & PLATINUM	Price April 13	+ or — on week
Anglo American Inv.	8½	+½
Casts	24/-	+9d
Cons. Diam. of S.W.A.	7	
De Beers Defd. Bearer	5½	
De Beers Pfd. Bearer	15½	+¼
Pots Platinum	8/3	
Waterval	14/4½	
COPPER		
Bancroft	43/9	—6d
Chartered	58/-XR	—1/6
Esperanza	4/6	—1½d
Messina	8½	+¼
Nchanga	13¼	
Rhod. Anglo-American	100/-	
Rhod. Katanga	19/6	+3d
Rhodesian Selection	34/3	—6d
Rhokana	38½	+¼
Rio Tinto	50¼	+¼
Roan Antelope	26/9	—4½d
Selection Trust	71/-	—2/-
Tanks	7½	+⅛
Tharsis Sulphur Br.	6¼	—¼
TIN (Eastern)		
Ayer Hitam	27/3	—3d
Gopeng	7/6	+1½d
Hongkong	7/10½	—3d
Ipoh	21/9	—1½d
Kamunting	6/10½	
Kepong Dredging	3/1½	—1½d
Kinta Tin Mines	11/6	
Malayan Dredging	8/1½	
Pahang	11/6	
Pengkalen	10/4½	—4½d
Petaling	9/3	+4½d
Rambutan	17/9	+3d
Siamese Tin	5/7½	
Southern Kinta	17/6	+1½d
S. Malayan	7/1½	—1½d
S. Tronoh	10/7½	+1½d
Sungei Kinta	11/3	
Tekka Taiping	7/-	—3d
Tronoh	7/6	+1½d
TIN (Nigerian and Miscellaneous)		
Amalgamated Tin	13/6	—1½d
Beralt Tin	30/3	+1/6
Bisichi	7/-	
British Tin Inv.	19/9	+10½d
Ex-Lands Nigeria	2/6	—1½d
Geevor Tin	12/4½	—3d

TIN (Nigerian and Miscellaneous) contd.	Price April 13	+ or — on week
Gold & Base Metal	2/6	—1½d
Jantar Nigeria	8/1½	
Jos Tin Area	13/9	
Kaduna Prospectors	2/6	
Kaduna Syndicate	2/6	
London Tin	7/9	+3d
United Tin	3/-	+1½d
SILVER, LEAD, ZINC		
Broken Hill South	50/-	
Burma Corporation	2/7½	
Consol. Zinc	45/-	+2/3
Lake George	12/4½	—3d
Mount Isa	51/6	+9d
New Broken Hill	35/3	+9d
North Broken Hill	70/-	
Rhodesian Broken Hill	12/3	
San Francisco Mines	23/6	
Uruwira	6/-	+7½d
MISCELLANEOUS BASE METALS & COAL		
Amal. Collieries of S.A.	48/6	
Associated Manganese	38/9	
Cape Asbestos	11/9	+1/-
C.P. Manganese	40/-	
Consol. Murchison	62/6	+1/3
Natal Navigation	2¾	
Turner & Newall	106/6	+2/9
Wankie	18/6XD	+3d
Witbank Colliery	4¼	—¼
CANADIAN MINES		
Dome	$30XD	
Hollinger	$35	+3
Hudson Bay Mining	$110	+1
International Nickel	$117½	+½
MiningCorpn.ofCanada	£6⅞	+¼
Noranda	$167	+4½
Quemont	£8¼	+¼
Yukon	4/3	
OIL		
British Petroleum	76/-	+1/-
Apex	28/-	+3d
Attock	46/3	+7½d
Burmah	5¼	+⅛
Canadian Eagle	52/6	+1/3
Mexican Eagle	20/7½	—1½d
Shell	6¼	+¼
Trinidad Leasehold	31/9	+1/1½
T.P.D.	25/6	+3d
Ultramar	28/9	—6d

COMPANY NEWS AND VIEWS

Anglo American to Provide Finance for New Welkom Capital Expenditure Plan

It has been announced that the Welkom Gold Mining Company has accepted an offer by the Anglo American Corporation of South Africa to subscribe immediately for 1,250,000 shares at 22s. 6d., the proceeds to be used in repayment of drawings on existing loan facilities. The Corporation is also to make available fresh loans of up to £2,500,000 until December 30, 1959, carrying interest at 6 per cent per annum on the amounts drawn. In consideration for granting these new facilities the Anglo American Corporation will be granted the right to subscribe for a further 1,250,000 shares at 27s. 6d. per share at any time up to December 30, 1958, the proceeds to be used towards the repayment of any amounts outstanding.

The finance received by Welkom as a result of this agreement will be used to finance the sinking of a new shaft system in the south western section of the property and for increasing the capacity of the reduction plant. Full particulars of these projects will be given in the chairman's review which, together with the annual report and accounts of the company, will be despatched to shareholders on May 2.

It has been apparent for some time that Welkom would be in need of additional capital and thus the latest proposals will come as no great surprise. However, the fact that the Anglo American Corporation has followed up its subscription earlier this year for 1,000,000 shares of the company at 30s. each will, with the latest proposals, be taken as an expression of confidence in the long term future of the mine. Moreover, the receipt by Welkom of some £1,400,000 from the present issue will more than meet its current financial shortages and should go a long way towards seeing the mine through its present stage of heavy expenditure.

From the point of view of future development in the south western part of the property, where boreholes have disclosed some exceptionally rich values, however, the news that a new shaft is to be sunk is particularly important. And while the mine's milling grade must eventually benefit substantially from stoping in this area, the decision to increase the crushing capacity from its present level of 125,000 tons a month augurs well for a future reduction in working costs and the establishment of a much improved basis for economic operation.

As a result of the latest subscription the issued ordinary capital of the company will have been increased to £3,062,500 in 5s. shares, while in the event of the subscription rights over a further 1,250,000 shares being exercised, the potential ordinary capital by 1958 could become £3,375,000.

Continuing Operations in the North of Freddies Consolidated Considered Justified

In a circular from Freddies Consolidated Mines to shareholders covering in detail operations since the amalgamation of the old Freddies North and South Properties which took place on June 1, 1954, it is stated that a continuance of operations in the North shaft areas is considered justified. This decision has resulted from careful consideration of the formidable difficulties to be overcome in an endeavour to make the mine payable and has been taken in the knowledge that considerable further expenditure will be necessary. An important factor which led to the decision was that, so far, only a small area of the mine had been explored. Further operations, it is thought, should, therefore, be continued for as long as there are reasonable grounds to hope that additional ore reserves may gradually become available and that satisfactory values may be disclosed.

In amplification of a table which shows stoping values carried out in each of the four shaft areas since amalgamation, it is stated that average values at North 2, South 1 and South 2 shaft areas have dropped during the past five to six months. In consequence, the average value of the ore stoped during the five months ended February, 1955, has been 253 in. dwt. as compared with 305 in. dwt. during the preceding four months. This has naturally had a material effect upon the value of ore milled and the total revenue from gold. Values at North 1 shaft area have, however, remained steady since the merger.

Commenting on the advantages which it was hoped would flow from carrying out selective mining over the large claim area served by the four shafts, and the greater flexibility which would result from joint mining operations, the circular points out that the selection of higher grade stopes has not proved feasible. This was due to the severity of the faulting encountered which prevented the establishment of sufficient ore reserves for the purpose.

It will be recalled that the South reduction plant was not included in the recent sale of Freddies Consolidated No. 2 South shaft to Free State Geduld Mines. The reason for this exclusion was that although the North reduction plant is sufficient for the needs of the mine at present, changing circumstances may necessitate the use of the South plant in the future.

Geoffries in 1954

No further prospecting operations were carried out by General Exploration, Orange Free State, during the year ended December 31, 1954. Referring back to the chairman's statement to shareholders in respect of the year 1953 it was reaffirmed that the most important result achieved by the company since its inception was the discovery through drilling in the Van den Heeversrust area of the O.F.S. of certain upper reef zones believed to be in the Elsburg series. In this area, borehole results were regarded as most promising and warranted further exploration by means of mining operations at an appropriate time. In the event of a mining company being formed to work this ground "Geoffries" will participate by way of vendors and subscription rights. It is not, however, considered that any additional information of importance can be obtained by means of further boreholes. Consideration is, therefore, now being given to the possibility of further investigating the potentialities of the VDH area, and to the method by which it may be exploited to the best advantage. It was emphasized that such information as becomes available from operations at neighbouring mines applies only to the basal reef horizon and not to the upper reefs.

Revenue earned during the year rose to £13,327 from £13,142. After deducting expenses and crediting an amount of £69,798, representing a transfer from general reserve for the purpose of writing down investments, the adverse balance carried forward was £37,585 as compared with £37,277 previously.

Record March Quarter Diamond Sales

Diamond sales affected by the Central Selling Organization on behalf of South African and other producers during the March quarter of 1955 broke all records previously established in respect of both gems and industrials. In the case of the latter, continuing stockpiling activities by the U.S. Government were to a large extent responsible, while sales of both gems and industrials reflected the steady improvement in U.S. business activity. (See *Mining Journal*, April 8, page 376.)

Quarter	*Gems*	*Industrials*	*Totals*
1955	£	£	£
March	15,231,054	6,936,763	22,167,817
1954			
December ...	10,866,174	5,198,192	16,064,366
September ...	11,232,441	3,137,337	14,369,778
June	11,737,546	3,326,371	15,063,917
March	11,773,849	4,881,215	16,655,064
Total for 1954 —	45,610,010	16,543,115	62,153,125

Anglo-French to Offer 100,000 £1 Shares

In order to provide funds for investment rights which will accrue, and to strengthen its cash resources, the Anglo-French Exploration Company is offering 100,000 £1 ordinary shares to members at par payable in full on application. The new issue will be made in the proportion of one new share for every £8 ordinary stock held at the close of business on May 7, 1955.

The present capital of the company is £800,000 in £1 stock units. It is not proposed that any part of the new issue should be underwritten.

DIVIDENDS

Anglo American Corporation of South Africa 50% (May 13)
Camp Bird 10% (May 12)
De Beers Consolidated 120% (May 3)
Electrolytic Zinc of Australasia 15% *i* (May 6)
Falcon Mines 4½d. (May 10)
Pengkalen Pref. Ord. and Ord. 20% *i*; Pref. Ord. 15% *i*; Ord. 5% *i* (April 29)
Rhodesian Anglo American 24% *i* (April 29)
Renong Tin Dredging 15% *i* (May 12)
Tekka-Taiping 5% *i* (May 13)

i interim

CORRECT SOLUTION TO "UNICONE" CROSSWORD No. 4 APPEARING ON PAGE 417

ACROSS: 1, Pyramid; 5, Apples; 9, Downcast; 10, Epoch; 12, Charm; 14, Longways; 18, Enamoured; 19, Cowl; 21, Hose; 22, Thereupon; 24, Thrilled; 28, Anise; 30/31, Tiled Bathroom; 32, Caesar; 33, Sturgeon.

DOWN: 1, Peddle; 2, Rowan; 3, Macaw; 4, Dusty; 6, Plea; 7, Loom; 8, Schedule; 11, Principal; 13, Head Gear; 15, Grapevine; 16, Apostles; 17, Surfeit; 20, Phonetic; 23, Odd Man; 25, Heart; 26, Ichor; 27, Loose; 28, Aloe; 29, Idea.

ROSE DEEP, LIMITED

(Incorporated in the Union of South Africa)

Extracted from the Annual Report for the Year Ended December 31, 1954.

Authorized and Issued Capital £595,000 in 17s. Shares, fully paid

Tons Milled 839,000	**Gold Recovered 128,079 f.oz.**	Per ton milled
Working Revenue	£1,598,967	£1 18 1
Working Expenditure	1,462,025	1 14 10
Working Profit	£136,942	£0 3 3
Add Sundry Revenue *less* Expenses	18,975	
	155,917	
Taxation	21,711	
Profit after Taxation	134,206	
Balance of Income and Expenditure Account	239,650	
		£373,856
Expenditure on Mining Assets, Trade Investments and Reduction of Capital		68,802
Balance of Income and Expenditure Account at December 31, 1954		£305,054

The ore reserve at December 31, 1954, was re-estimated as follows :—

Reef	Available			Shaft and Safety Pillars			Total		
	Tons (000s)	Value Dwt.	Width Inches	Tons (000s)	Value Dwt.	Width Inches	Tons (000s)	Value Dwt.	Width Inches
Main Reef ..	514	3.7	62.4	1	5.4	45.7	515	3.7	62.4
Main Reef Leader ..	61	3.6	54.1	22	4.0	45.4	83	3.7	51.4
Composite Reef	102	3.8	54.3	110	4.5	56.6	212	4.2	55.5
South Reef ..	288	3.4	58.1	74	5.8	63.5	362	3.9	59.1
Total ..	965	3.6	59.6	207	4.9	57.2	1,172	3.8	59.1

Compared with the previous year the available reserve decreased by **205,000** tons, the width being **0.8** in. higher and the value unaltered.

At the forthcoming Ordinary General Meeting it is proposed to consider and, if thought fit, pass a Special Resolution reducing the authorized capital to **£490,000** by returning **3s. 0d.** per share in cash to shareholders.

The full Report and Accounts may be obtained from the London Secretaries, A. MOIR & CO., 4 London Wall Buildings, E.C.2.

TRANSVAAL CONSOLIDATED LAND AND EXPLORATION COMPANY, LTD.

(Incorporated in the Union of South Africa)

AUTHORIZED AND ISSUED CAPITAL—£465,119 in 930,238 Shares of 10/- each

The Report and Accounts for the year ended December 31, 1954, contain, *inter alia*, **the following information :—**

PROPERTY—At December 31, 1954, the Company's holding of farm property and mineral rights in the Transvaal comprised :—

Freehold and mineral rights	111,875 acres
Mineral rights only	3,429,266 acres

together with interests with other Companies in sundry freehold and mineral rights in the Pilgrims Rest district of the Transvaal.

The Company's holding of Township land in the Johannesburg Municipal Area comprised the freehold of 32,136 acres of residential plots in townships, sold in leasehold.

Investments—The shares and debentures have been taken into account at a book value of £449,889, a net increase of £25,400 compared with the total at the end of the previous year, after allowing for a credit adjustment of £5,667 in respect of depreciation. All investments with Stock Exchange valuations appear in the books at cost or market value at December 31, 1954, whichever was the lower ; unquoted securities have been valued at cost or in accordance with the conservative valuation placed on them by the Directors, whichever was the lower. The market value of the quoted investments at December 31, 1954, was £818,061.

MINERAL INTERESTS

Tributes—The royalties derived from properties let on tribute totalled £125,884 mainly in respect of the working of asbestos, chrome and tin deposits.

Platinum Prospecting Company (Proprietary) Limited—This Company was formed on October 20, 1954, to acquire the assets of the Platinum Prospecting Association No. 3 in which the Company had a 45 per cent interest. The Company's share of the consideration payable by the Platinum Company in respect of the purchase of the assets of the Association amounts to £102,543 and is included in the figure of Debtors and Payments in Advance shown in the Balance Sheet. The Company subscribed for 35,151 shares in the Platinum Company being its proportion of the working capital required by that Company to enable it to continue its prospecting and development operations for a further period. In due course, when transfer of the assets to the Platinum Company has been effected, a further 102,543 shares will be subscribed for by the Company. The Platinum Company continued the underground exploration of the Brakspruit property, which work was restarted by the Association during 1953.

Rietfontein (T.C.L.) Mine—Most of the plant and equipment at this property has now been sold.

OPERATIONS

Van Dyks Drift Colliery—The quality of coal produced during the year has remained consistently high and mining conditions have been generally good.

Due to inadequate railway facilities the colliery, as in recent years, operated on a restricted output, which was produced by working the six available districts for half the year and only five districts for the remaining six months.

CURRENT ASSETS

The **net Current Assets** at the end of the year amounted to			£559,011
made up as follows :—			
Mortgage Bonds and Other Securities		£13,913	
Stores		44,895	
Debtors and Payments in Advance		144,603	
The Transvaal Coal Owners' Association (1923) (Proprietary) Ltd.		25,482	
Deposits on Call		580,616	
Cash at Bankers and in Hand		20,016	
		£829,525	
Deduct : **Liabilities and Provisions** :—			
Shareholders—Dividends	£99,834		
Creditors	30,002		
Provision for claims in respect of forfeited dividends	12,013		
Provision for Taxation	128,665		
		270,514	
			£550,011

EXTRACT FROM INCOME AND EXPENDITURE ACCOUNT

Profit before Taxation		£350,818
Taxation		65,343
Profit after Taxation		285,470
Balance of income and expenditure account at December 31, 1953		364,683
		£650,153
This amount has been dealt with as follows :—		
Dividend No. 32 of **2s. 0d.** per share		93,024
Balance of income and expenditure account at December 31, 1954		£557,129

The full Report and Accounts may be obtained from the London Secretaries, A. MOIR & CO., 4 London Wall Buildings, E.C.2.

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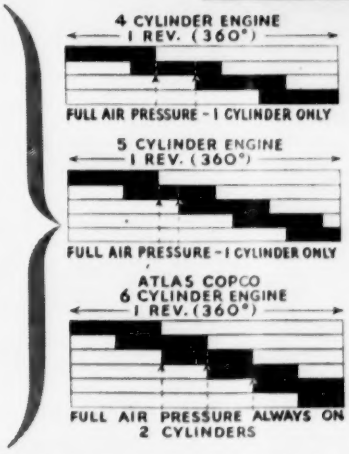

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VEE-ROPE DRIVES
Wigglesworth (F.) & Co. Ltd.

WATER SUPPLY EQUIPMENT
Thom (John) Ltd.

WELDING
Cementation Co. Ltd.

WELDING ELECTRODES
Metropolitan-Vickers Electrical Co. Ltd.

WELDING EQUIPMENT
British Insulated Callender's Cables Ltd.
English Electric Co. Ltd.
Lincoln Electric Co. Ltd.
Metropolitan-Vickers Electrical Co. Ltd.
Siemens-Schuckert (G.B.) Ltd.

WIRE ROPE & ACCESSORIES
British Ropes Ltd.

WINDING EQUIPMENT — ELECTRIC
British Thomson-Houston Co. Ltd.
English Electric Co. Ltd.
General Electric Co. Ltd.
Metropolitan-Vickers Electrical Co. Ltd.

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